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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric VOC measurements at a High Arctic site: characteristics and source apportionment" *by* Jakob B. Pernov et al.

Anonymous Referee #2

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This manuscript by Pernov et al. reports atmospheric non-methane volatile organic compounds (VOCs) measurements at Villum Research Station at Station Nord, Greenland, from April to October 2018. Given the scarcity of VOC measurements in the Arctic and the significance of VOCs in the background atmosphere (formation of ozone, CO, and aerosols), this study will make a valuable contribution to the body of literature. The manuscript is overall well written and structured. My main concern is that the figures do not support the discussion and conclusions (see comments below). Additionally, the introduction could be more succinct.

- Diurnal variation

The authors say that certain compounds (e.g. DMS and OVOCs) follow a diurnal cycle. This is not shown in Figure 1 and I would like to see a Figure describing, for each compound of interest, the mean diurnal cycle per season.

- Springtime DMS

I have difficulties reading satellite images (Figures S4 and S5). The caption says that the presence of open leads can be seen southwest of the station but I don't even know where the station is. Then, according to the authors, "the back-trajectory calculations confirmed that, during the DMS emission episodes, the air masses (. . .) traversed over the open leads before reaching the station". First of all, what is the meaning of the different colors? I do not understand Figure S6. Then, this Figure does not show that air masses traversed over the open leads. If you want to show this, then please consider combining satellite images and back-trajectories on a single Figure.

- Biomass burning

Contrary to what the authors say, Figure 4 does not show "evidence of overlap between air mass history and active fires during this period". Figure 4 shows all fires from mid-August to mid-September and all back-trajectories. This does not prove that a given fire existed at the time an air mass traveled in the area. I expect a more thorough statistical analysis here. In order to link the fires up with back trajectories, you could for instance cross check the latitudes and longitudes to a, let's say, 1-degree accuracy. If a longitude and latitude match exists between a fire and a back-trajectory, then check if the time of the fire product and the back-trajectory were within, let's say, 1 hour. Thus, a match is completely defined as a back-trajectory crossing over a fire within 1 hour and within 1-degree difference.

- Spatial origin of the Marine Cryosphere factor

Figure 6 (trajectory frequency) shows more frequent air masses from coastal regions but does not show that these areas are responsible for enhanced marine cryosphere

factor. It does not support this sentence in the conclusion “Back trajectory analysis yielded MIZs around the coasts of Greenland and the Arctic Ocean as source regions”. I suggest a Potential Source Contribution Function (PSCF) analysis to determine probable locations of emission sources.

Line-by-line comments:

Line 10: “we report a long-term dataset”. The authors report measurement from April to October 2018, i.e., less than a year. This is not what I would call a “long-term dataset”. Please edit this sentence.

Line 33: Define VOCs and NOx.

Line 49: Define DMS.

Line 108-109: “with low time resolution”. Be more specific here. Gautrois et al. (2003) collected about one sample every 9 days. Additionally, the authors did not use a GC-MS, but a combination of GC-FID and GC-ECD.

Line 110: You don’t really explain why we need high time-resolved measurements of VOCs. Do you expect a high temporal variability? How about the global atmospheric watch reactive gases measurement network (Schultz et al., 2015) – Aren’t these measurements enough?

Line 111: Same comment as above. In the previous sentence, you highlight the need for long-term measurements of VOCs in the Arctic. While a substantial contribution to the literature, you “only” report several months of data. You could perhaps emphasize more the high temporal frequency of your measurements.

Line 123: Did you filter data for local contamination? If so, how?

Line 125, Table S1: I have a hard time understanding how the seasons were defined. Skov et al. (2020) recently used a different (and more straightforward) definition: winter from December to February, spring from March to May, summer from June to August,

and fall from September to November.

Line 137-138: “measurements were interrupted for short periods ranging from days to weeks”. Could you please add a Table summarizing, for each month, the number of hours of operation?

Line 144: “within the analytical uncertainties”. Please refer to Table 1 here. Additionally, how often did you perform a calibration?

Line 157: How exactly did you remove the influence of local pollution. What criteria did you use for wind speed and direction?

Lines 179-181: Did you perform a sensitivity test? How does changing concentrations below LOD and missing concentrations influence the PMF results?

191: “automatic weather station placed close to the measurement site”. How close? Be more specific.

Lines 206-207: “The trajectory length was varied between 240 and 336 hours”. Why did you use two different trajectory lengths? Additionally, I would recommend the use of shorter back trajectories (typically 5-7 days max) as uncertainties increase with time along the way (Stohl, 1998). I would also like to see a more critical discussion on back trajectories; they only give a general indication of source regions.

Line 217: “certain compounds (DMS and OVOCs) revealed a diurnal cycle that closely follows radiation”. Please make a Figure to prove this.

Line 219: “summer when a diurnal pattern following sunlight was observed”. Same as above, please demonstrate this.

Lines 225-227: “a clear diurnal variation was observed in the period July-August, with peak mixing ratios occurring around midday (Fig. 1 a, c, d, e). The diurnal variation was less pronounced in April-May and September-October, highlighting the dependence on sunlight”. None of this is shown in Figure 1.

Line 255: “DMS showed a clear diurnal cycle during sea ice melt in the summer months correlating with sunlight intensity”. Prove/illustrate it.

Line 257: “Elevated DMS mixing ratios”. What do you mean by “elevated”? Be more specific.

Lines 259-261: see comment above. As is, Figures S4-S6 do not do a good job at showing this.

Line 273: “illustrated here by changes in wind speed”. I would expect changes in wind direction to be a more useful tracer of change in meteorological conditions.

Lines 286-287: “In addition to the previously mentioned dependence on the diurnal variations of sunlight, providing strong evidence of a local photochemical source”. Again, this has not been demonstrated.

Line 344: “a sink during the summer”. A sink of what?

Line 351: “336 hours backward in time”. That’s too long to my point of view. Use max 5-7 days.

Lines 383-384: “This factor shows an enhanced diurnal variation with a clear correlation to sunlight during the summer months (Fig. 5, Top)”. Again, Figure 5 does not illustrate this.

Lines 406-407: “Periods of high contributions and clear diurnal pattern by the Marine Cryosphere factors starts on June 23”. I don’t see the “clear diurnal pattern”.

Lines 426-427: “Although, the variation of the Marine Cryosphere Factors seems not to be driven mainly by the dependence on horizontal wind speed (Fig. S2)”. Figure S2 does not illustrate this. What is the correlation coefficient between the Marine Cryosphere Factor and wind speed?

Lines 428-429: “given the distance of the measuring site from open water”. What is the distance between the station and open water?

Lines 443-454: see comment above on Figure 6 and the fact that it does not show that coastal regions are responsible for enhanced marine cryosphere factor.

Section on Arctic Haze: please mention/discuss more clearly that you do not have data in wintertime, when Arctic Haze is expected to be at its maximum.

References

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